Leica R-Lenses

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Chapter 7: 28-90 mm lens

__ LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH

Introduction

The zoomlens as a species of lens design has had a strange evolution. The first design seems to be the Vario-Glaukar 1:2.8/25-80 mm for 16 mm cine cameras, created by Siemens around 1936. Especially in movies, the idea of a smoothly changing rate of magnification is very valuable as it can dispense of the stationary camera, moving on a trolley over rails. The first patent for a zoomlens is from 1902 by a USA company. The idea of a zoomlens is now more than a hundred years old. The first zoomlenses for 35 mm cameras were regarded as toys and even during the eighties of the previous century the Leica company declared that zoomlenses would never surpass the image quality of fixed focal lengths. It is Mr Kölsch who deserves the credit for two major breakthroughs in Leica lens design: the aspherical surface and the high quality zoomlens. The seminal LEICA VARIO-ELMARIT-R 35-70 MM F/2.8 ASPH and the Vario-Apo-Elmarit-R 70-180 mm F/2.8 are the proof in the pudding: zoomlenses can be as good as fixed focal lengths.
Nowadays the situation is reversed: it are the fixed focal lengths that must prove their superiority against the challenge of the zoomlens. There is no doubt: the zoomlens does not lend itself to high apertures (in the world of the digital camera this statement is not true!) and the maximum aperture is F/2.8. But with current film technology the best ISO 200 and ISO 400 slide films (and 400 ISO BW films) can compensate for the one or two stops difference between fixed focal lengths and zoomlenses.

The zoomlens has a higher number of lens elements that can all be used to correct the optical aberrations and the designer has more tools to optimize his design. We know that with fixed focal lengths there is one optimum distance (or magnification) for which the lens can be corrected. In zoomlens design the same principle holds: there is only one focal length for which the design can be optimized. The choice is obvious: one can select the medium position, the wide angle side or the tele side. For the new LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH, Leica has opted for an optimization of the 50 to 90 mm range.

The designer of a zoomlens has more tools to correct the lens, but the mechanical design and engineering are more demanding. There is clearly a difference between assembling a lens with 6 elements in a stationary mount and a lens with 11 elements in a moving mount. It is already a hefty task to manufacture and assemble components with a precision within 0.01 mm consistently. The additional requirement for a zoomlens is that this same level of accuracy must be maintained with moving components. Leica does check the precision of the lens with a testcycle of 50.000 movements of the lens mount.
This new Leica zoomlens has a number of innovative features that elevates zoomlens design to a new level.

It is the first Leica zoomlens that has a zoom range above a ratio of 1:3, to be exact it is 1:3.214, very close to the magic mathematical number pi (3.14...).

The second innovation is a new and very elaborate mechanical design for the movement of the lens groups.

The third innovation is the ergonomics: the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH has one of the smoothest lensmounts I have touched, considering the fact that the lens has been made for manual focusing with a fully mechanical mechanism. The size of the lens is relatively small and fits in between the smaller Vario-Elmar-R 28-70 mm f/3.5-4.5 and the larger Vario-Elmarit-R 35-70 mm f/2.8 ASPH. That is quite good, given the additional focal length of 20 mm. The diameter of the lensmount could be held down by employing quite thin but very stable aluminium tubes. If you press very hard on the distance ring, you will increase the friction and this phenomenon has caused some users to question the mechanical stability of the new generation of zoomlenses. This is not the case, and one needs to get used to the idea that modern lenses have a different feel compared to previous generations.

The fourth area where innovations can be detected is the cosmetics: the lens has a beautiful shape and very impressive black finish.

We may add that the lens has its share of electronics with the electronic exposure compensation, useable with R8/9. No news here, but one should see it as a fifth area.
The ROM (electronic data and signal relay) contact ledge transfers information from the lens (focal length, aperture compensation and vignetting data) to the camera for correct exposure determination and flash settings (zoom reflector).

__ LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH

__Zoomrange

The choice of focal lengths is very practical. Many years ago Canon has analysed thousands of photographs and concluded that the most often used apertures and speeds are 1:8 and 1/125 and that the most used focal lengths were within the 28 mm and 90 mm range. If we believe these studies, the new Leica lens would cover the most used range of focal lengths with one zoom movement.

This Leica lens is a fine addition to the expanding range of Vario-lenses, but it cannot be a jack of all trades.

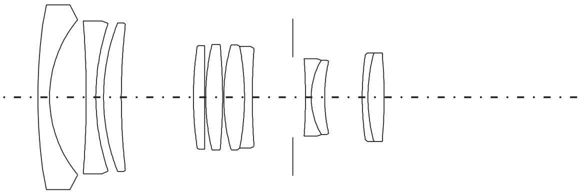
A macro facility is not available, but can be found in the companion lens Vario-Elmar-R 35-70 mm f/4 . And for most applications, the near focus limit of 0.6 meter on the 90 mm position may suffice. The aperture range from 1:2.8 to 1:4.5 has enough speed for current high quality medium speed films. One would have hoped for a slightly wider aperture at the telephoto side of the zoomrange. But that wish would have clashed with the desire for a compact lens. Remember that the famous Vario-Elmarit-R 35-70 mm f/2.8 had a front diameter of 88 mm and extrapolating this to the 90 mm position, one would have to live with a lens with a diameter in the neighbourhood of 120 mm and a much higher weight due to the proportionally heavier glass lenses.

The aperture ring has numbers from 2.8 to 22 and one should be aware that this range only holds for the focal lengths from 28 to35 mm.
The 50 mm aperture starts at 3.4 and the 90 mm at 4.5.
If you are at the 90 mm position, the aperture setting of 2.8 corresponds to 4,5 and the 22 is in fact 36.

One should be careful when using a handheld meter or when one uses the A-setting and wants to select a specific aperture. It is easiest to use the aperture indication in the finder.

__Optical demands and mechanical construction

The design has 11 elements in 8 groups and employs two aspherical surfaces, one at the first surface of the front element and one at the second surface of the last element, incidentally the same as in the original Noctilux 50 mm f/1.2.
The lens has three moving groups that are being guided in milled slots with a precision of 0.010 to 0.005 mm.



The challenge for the Leica engineers was to design a lens that had to fit into three dimensions of requirements: performance, haptics and cosmetics. These dimensions are partly at conflict with each other. And we have to add another dimension, that is the manufacture of the lens. In this area Leica has learned a lot from the previous designs. The main problem area is the narrow tolerance band for the manufacture and assembly. The lens consists of eleven lens elements, that are precision grinded and have a surface treatment to reduce surface irregularities to a sub micron level, in fact here we are talking about tolerances at the nanometer scale (0.001 micron). To deliver the required and calculated performance, the lens element must be fitted into the mount without any stress, as the slightest strain on the lens will deform the surface and produce unwanted optical aberrations. One should be aware that the accurate and strain free mounting of the lens elements is a big challenge. There are additional challenges too: a lens element needs to be blackened at the sides to reduce the possibility of flare. This is accomplished by painting the sides of the lens with a black paint, still done by hand by experienced workers. But a thick (relatively speaking!) elastic layer implies that the lens could move ever so slightly within the mount. One solution might be to press the glass element into its mount, but too much pressure is not good at all. So one has to carefully balance the thickness of the layer of paint with the requirement of a strain free fitting.

In the area of lens grinding and shaping we are operating on a nanometer dimension. The jump from this optical dimension to the mechanical dimension of the mount and the accuracy of assembly is a jump from nanometer scale to micrometer scale (0.001 mm), but this micrometer scale is still incredibly small. And the designer must be aware of this jump to assure that his calculations can be met in the realm of manual assembly, even when using sophisticated instruments to check the precision of the assembly. The new zoomlens has more than 40 main mechanical parts (excluding the elements and electronics and the aperture mechanism) that have to be assembled with a precision of 0.010 to 0.005 mm.

One of the biggest problem areas in lens assembly is the possible decentring of lens elements. Decentring of lens elements can be a tilt or a lateral displacement (relative to the optical axis) and will occur almost always during lens assembly unless one can work with very narrow tolerances. Most optical programs have a special module to study the effects of decentring and can indicate how much decentring is allowable before one sees a deterioration of the image quality.

Decentring in general brings loss of contrast and more astigmatism. A special construction is required to ensure that the very tight tolerances that this lens demand (due to the mechanical and optical constraints of a 1:3 zoomrange). The manufacture of parts can never be done in a zero-tolerance environment. Therefore a certain amount of tolerance in the system must be accepted. In general one can approach this problem in three ways: one can allow for adjustments during the assembly process and try to pair plus/minus parts to get the correct fit (old Leitz method), one can do a Monte Carlo statistical analysis to investigate where the most sensitive problem areas are and distribute the problematic aspect through the system by relaxing the constraint (Zeiss method of relaxation) and now Leica uses a third method. This is the method of mechanical compensators that are part of the mechanical construction and are already taken into account at the stage of optical design and calculation. This is the novel idea. Compensators themselves are not new as a technique. In this case the lens element can be displaced by a small amount by a mechanical movement before being fixed in place. The displacement is controlled by a MTF measurement at a very high scale of magnification

New too is the approach to design the lens optically and mechanically at the same time and in full interaction. The designer must be aware what is possible at the assembly stage as he cannot demand the impossible from the people during their work. The optical calculations are optimized to allow the people at the assembly line to hand adjust the compensator mechanism in such a way that the lens is always at optimum performance. Every single lens is being checked to perform as designed and especially the aspherical elements are very carefully adjusted. The result is a much lower tolerance band than would normally be possible. The care that is being lavished on the quality of the assembly can be read off from the time needed: it takes a worker more than two hours to assemble the lens. This close cooperation between design and assembly is one of the main causes for the consistently high quality of the Leica lenses and has now been brought to a new level. The assembly and adjustment instructions are part of the final lens design and the design is adapted to what is the best assembly practice.

No two lenses that leave the factory are absolutely identical. There is always some tolerance during manufacture.

The factory must set the lower limits of the performance that they can accept as being within the requirements as specified by the designers. A long as these requirements are met, a lens will be accepted by quality assurance. With the construction of the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH the statistical distribution within the tolerance range is significantly reduced.

Zoomlenses are difficult to manufacture to narrow tolerances because of the lens groups that have to move in a complicated path. Normally one uses a mount with guiding slots that govern the movements of the lens groups in relation to each other.

In most cases there are two or three slits and they are milled in the mount as open holes, in which the guiding rollers move. With open slits, however, the structural integrity of the mount can suffer, but with two slits and sufficiently thick walls, there is no problem. The price you have to pay is a heavy lens. One of the requirements for the new lens was its low weight. In this LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH we have three moving groups and therefore three guiding grooves. Now we cannot use the normal construction. (too heavy and/or too fragile). To ensure the necessary stability, one cannot use the open slit method, but must use internal grooves that can only be cut by special CNC machinery that Leica developed in cooperation with Weller, the leading manufacturer of this type of CNC tools. The milling movement creates a surface roughness that has to be smoothed to a tolerance depth of 0.01 mm to ensure that the guiding rollers move with the same resistance over the whole range. The mount of the new lens is made of quite thin and very high-grade aluminium that is specially selected to have the required stability. It is also selected because the surface reacts quite well to the black anodizing process ***(see image 1)***.

(image 1)

The result of all this effort is a lens with a very smooth movement of the focusing ring and focal length selection. With quite sensitive fingers one can feel some instances of friction when you go from 90 mm to 28 mm, so perfection is always relative.

__Optical considerations

The general image quality of this lens is of a very high order. Leica characterizes the lens as a travel and general purpose lens. This is undoubtedly true, but I would add that the performance of the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH does support professional photography of a very high calibre.

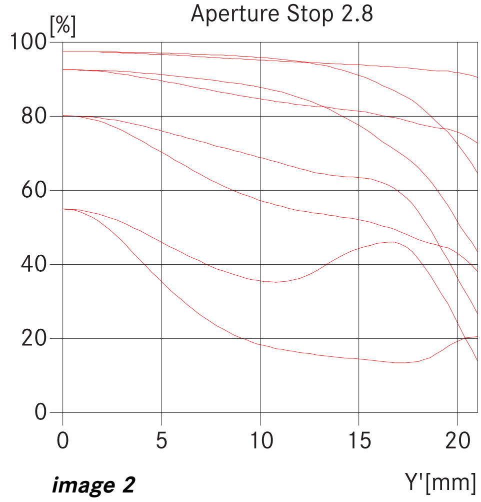
At 28 mm and full aperture (2.8) we have a high contrast image that can record above 150 Lp/mm in the centre of the image and more than 80 lp/mm in the outer zones ***(see image 2)***. Only the corners are weak with a soft recording of fine detail. Stopping down to 5.6 the performance of the centre now extends over an image circle of 12 mm diameter ***(see image 3)***. There is no trace of astigmatism and a slight field curvature. Some colour fringing is visible at very high magnifications. Distortion is visible with -3% (barrel distortion) and so is vignetting at 2.5 stops ***(see image 4)***.

At 35 mm and full aperture (2.8) there is a small improvement in the outer zones where the lens now records 100 lp/mm with good micro-contrast ***(see image 5)***. Distortion now is about -1%. At 5.6 we have optimum performance with a crisp rendition of very fine detail over most of the image area ***(see image 6)***. Vignetting is practically gone ***(see image 7)***.

At 50 mm and full aperture (3.4) we see a very high contrast and an exceptionally high resolving power of more than 150 lp/mm over a large section of the negative. There is still some faint colour fringing, but in practice one would be very hard pressed to note it ***(see image 8 and 10)***. At 5.6 we have impeccable performance that easily surpasses the quality of the Summicron 50 mm lens, especially in the outer zones of the field ***(see image 9)***.

At 70 mm and full aperture (4) the image quality becomes superb and we have an extremely high contrast and a very crisp definition of the finest details ***(see image 11)***. Stopping down to 5.6 does improve edge contrast and now the corners are quite good too ***(see image 12)***. Distortion is 1% (pincushion) and vignetting negligible ***(see image 13)***.

At 90 mm and full aperture (4.5) the best performance is reached and compared to the 70 mm position the outer zones and corners are now as good as the centre of the image ***(see image 14)***. Vignetting is gone and distortion is very low with 1%. The low distortion at the tele side of the zoomrange is quite remarkable. Often the behaviour of zoomlenses can be characterized as good in the middle range and weaker at both extremes ***(see image 15 and 16)***.



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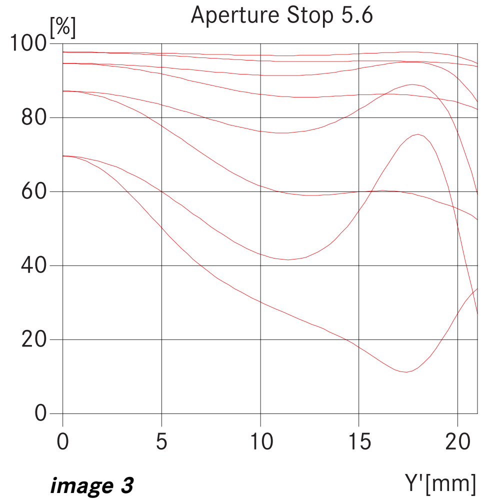

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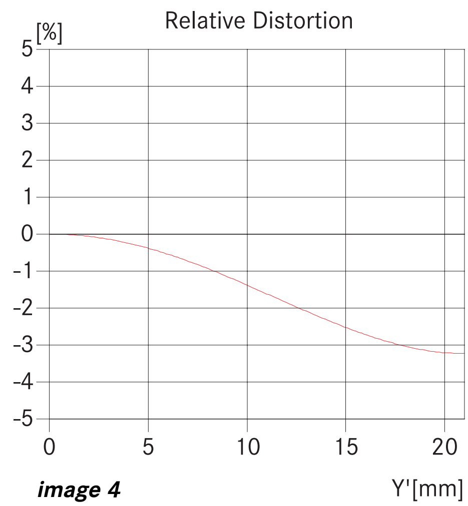

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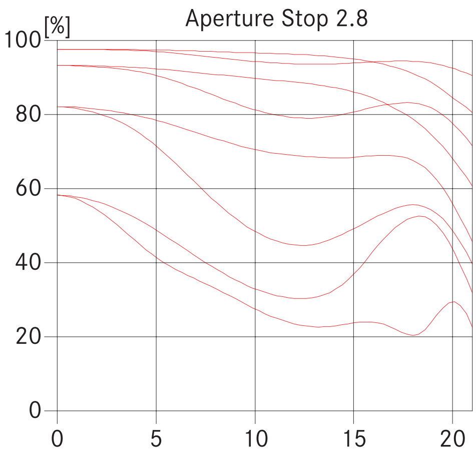

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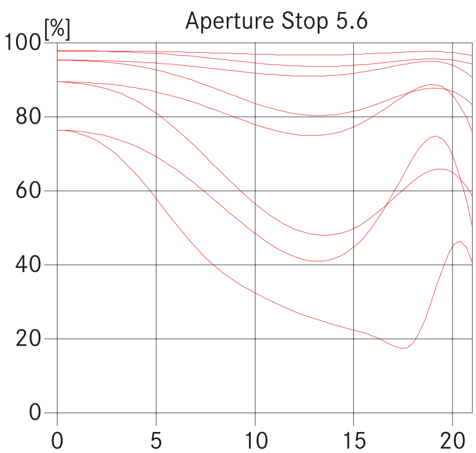

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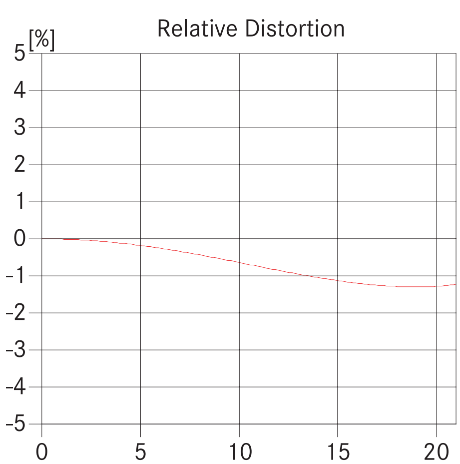

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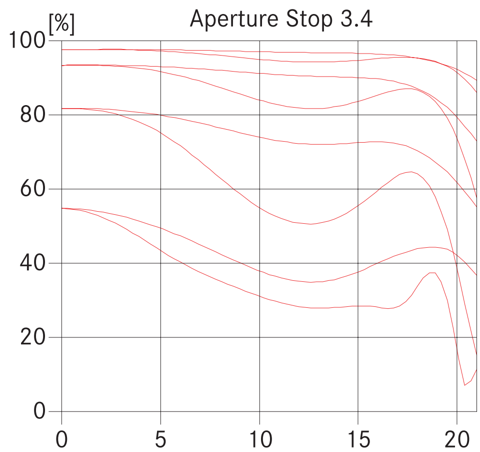

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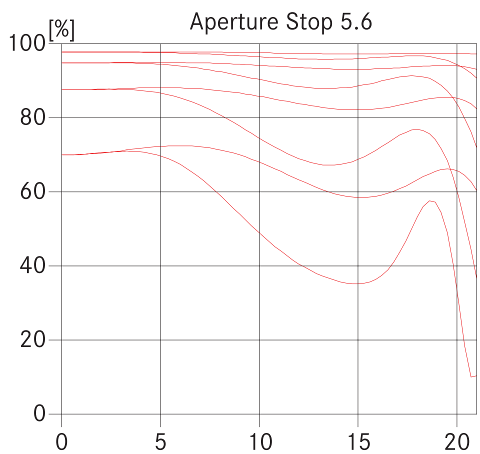

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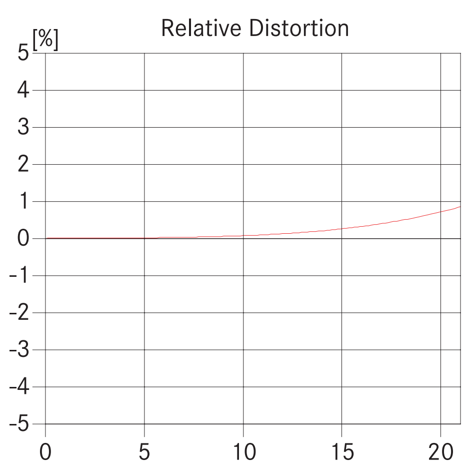

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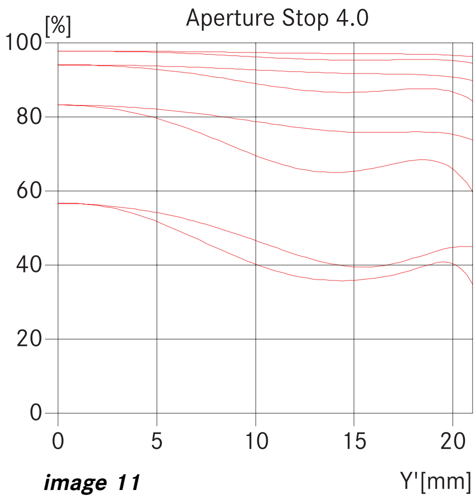

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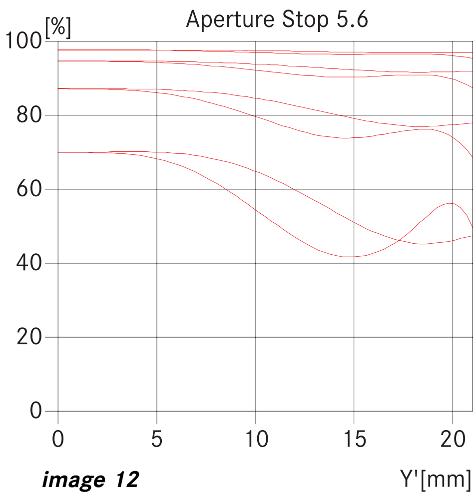

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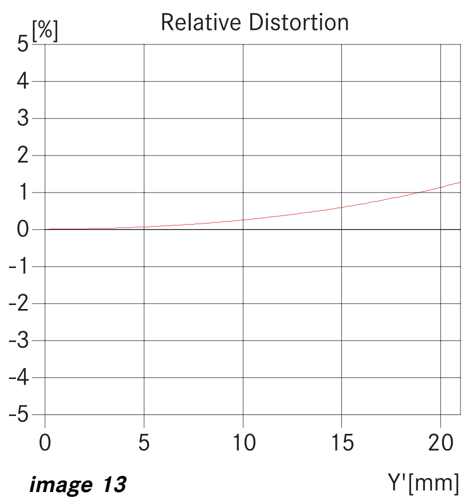

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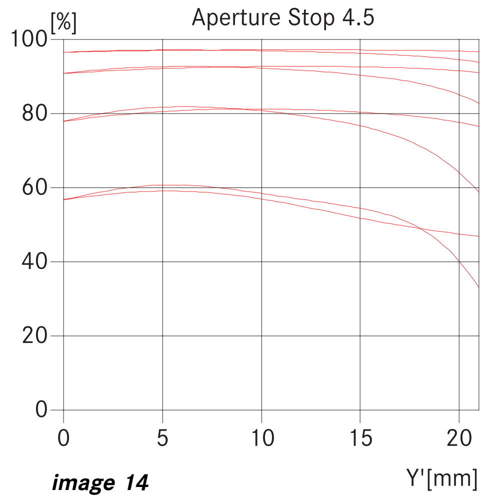

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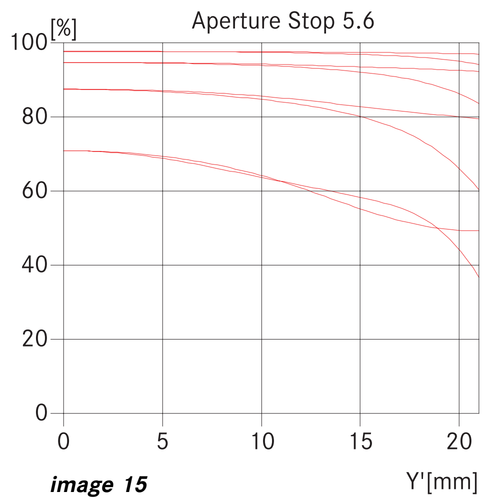

image 15

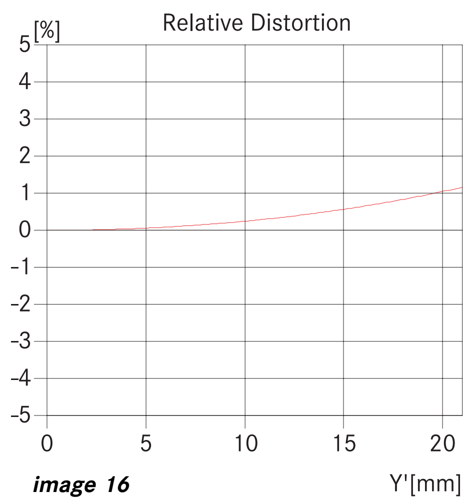

image 16

This is a lens with amazing characteristics. It offers outstanding quality and can be compared very favourably to the fixed focal lengths. A detailed comparison with the equivalent fixed focal lengths is possible based on the published graphs in earlier chapters and in the lens data sheets, available separately. The reader can do this him/herself.

The comparison with the Apo-Summicron-R 90 mm f/2 ASPH is interesting and does indicate where the advantages of fixed focal lengths may be found. A careful study of the properties of the individual lenses does help making the correct selection. The Apo-Summicron-R delivers at full aperture (1:2) the same performance as the Vario-Elmarit-R at the 90 mm focal length at f/4.5.
The Apo lens has a two stop advantage here. The greater depth of field and the more effective reduction of internal reflections (smaller lens diameters!) give the pictures with the Vario lens a smoother quality. With the Apo lens the sharpness plane is clearly isolated from the rest of the image and the unsharpess gradient is steeper. Stopping down the Apo-Summicron-R to 1:4 will make the differences disappear of course.

In general the fixed focal lengths will be more compact and offer a higher speed per focal length. Stopped down there is no longer a big difference and compared to older lens generations, the zoomlens often has better imagery in the outer zones of the image.

The images made with the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH have a very good colour fidelity, a very fine pictorial depth and realism. This is a lens for slide film and if you have not yet tried slide film, the acquisition of this lens might be a good incentive to try these films.

The wide zoomrange from 28 to 90 mm highlights another property of the reflex system: the normal finder screen of the R8/9 is a bit too dark at the 90 mm position and it is difficult to focus accurately at the 28 mm position. Here lies a new job for the engineers at Solms! Focussing at the wide angle range is often not very critical as depth of field will cover slight errors. If accurate focus is required, it is best to focus at 70 mm and zoom to 28 mm (or 90 mm and zoom to 35 mm).

In this range, focus constancy is abolutely spot on. Current Leica lenses score high marks in the areas of contrast and definition and reproduction of very fine detail. These characteristics can be inferred from the published MTF graphs, as long as you try not to read too much out of these graphs. One very critical area where the MTF can not provide information is the propensity to flare in its several aspects.

LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH image: Oliver Richter

__Flare properties

I made a special study of the flare properties of the lens, as this is the one area where lenses have to go 'a bout de souffle'. Veiling glare is hardly visible at all focal lengths, implying there is no loss of contrast when the background is much brighter than the subject itself. When the sun is obliquely shining into the lens, and is behind the subject, one can see some secondary reflections of small extent in the picture, but the well-known diaphragm blade reflections are not visible. With the sun flooding the image, there is of course a bleaching out of the picture details, but in such a situation one would change the position slightly to evade this direct confrontation with the sun.

In general I would say that for veiling glare the lens is better than the average Leica lens, and for secondary reflections it is slightly better.

__Conclusion

The new lens is an outstanding performer at all focal lengths. The compact size, the ergonomics and the performance are all balanced into what economists call a Pareto optimum. Any change in one of the parameters will degrade the quality of the whole. This actual image quality can only be guaranteed during production and assembly where the very tight tolerances and adjustment methods demand workmanship of the highest level.

The image quality of the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH is generally above what one expects from high grade fixed focal lengths and the focal length range secures it a premium role in the Leica R lens range.

LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH

image: Oliver Richter